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50 Publications to be taken into consideration for assessing patentability:

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GRÜNENWALD, Josef, et al.:

Retrofitting Possibilities in Large Turbo-generators. In: Brown Boveri Technik, No. 1, 1986, p. 14-21;

54 Method for Repairing a Connecting Device for the Electrical Connection and for Supplying and Removing Coolant Liquid to or from the Hollow Component Conduits of the Stator Winding Bars of Electric Machines

57 The method for repairing a connection device for electrical connection and for supplying coolant liquid to or from the hollow component conduits of the stator winding bars of electric machines includes the following steps:

a) Removal of the existing connection device (2) from the bar end by inductive heating;

b) Cleaning the bar end in the region where the new connection device is to be fastened;

c) Material-removing processing of the front of the bar end, especially by milling;

d) Introducing narrow slots (7) between adjacent conductor elements (1) in the front of the bar in the transverse and vertical directions

e) Sliding on a first connection element (2a) of copper that completely surrounds the bar end;

f) Filling remaining gaps between the first connection element (2a) and the outer surfaces of the bar end with copper and/or solder foil;

g) Filling the narrow grooves (7) introduced into the face of the bar with copper and/or solder foil (10) or a combination of both;

h) Inductive heating of the first connection element (2e) and the bar end and soldering while administering solder;

i) At least visual inspection of the solder connection so created;

j) Fitting a second connection element (2a) of copper to the free front of the first connection element (2a) by soldering;

k) Testing the connection device (2a, 2b) created this way for sealing tightness.

With this . . .

The following information was taken from the documents submitted by the applicant.

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Description

Technical Field

The invention relates to a method for repairing a connection device for the electrical connection and the supplying and removal of liquid coolant to or from the hollow conductor elements of the stator winding rods of electrical machines in which the connection device includes the hollow conductor elements, and if need be with a stator winding, also includes the solid conductor elements in addition to the hollow conductor elements. All conductor elements are surrounded by a metal component and are soldered to it and to each other, where the component protrudes beyond the conductor elements while forming a water chamber, and ends in a connection armature for supplying or removing coolant fluid.

Technological Background and State of the Art

In the stator winding head of water-cooled electric machines, the liquid coolant is supplied from annular collection conduits through insulation tube to the so-called water chambers on the end of the conductor bars. The water chamber is formed through a connection device in which the hollow conductor elements are surrounded by a metal component and are soldered to it and to another. The metal component protrudes beyond the conductor element while forming a water chamber. It ends in a connection armature for supplying and removing coolant fluid. The connection device also serves as an electrical connection at the same time.

The connection device is exposed to high mechanical stress (vibrations) during operation. Even the most minimal leaks lead to consequential damages to the electric machine. If such damages occur, the solder connections must be restored to the extent that this is possible at all. Usually only the removal or even the complete replacement of the stator winding remains an

option. Thus there exists a great need for a repair procedure that can be conducted without removing the stator winding.

Short Representation of the Invention

Underlying the invention is the objective of indicating a method for repairing a connection device of the type mentioned above which can be conducted easily and managed without removal or even replacement of the stator winding, but facilitates leakage-free solder connections.

This objective is accomplished in accordance with the invention by a repair method that includes the following steps:

- Removal of the existing connection device from the bar end by inductive heating;
- Cleaning the bar end in the region where the new connection device is to be fastened;
- Material-removing processing of the front of the bar end, especially by milling;
- Introducing narrow slots between adjacent conductor elements in the front of the bar in the transverse and vertical directions
- Sliding on a first connection element that completely surrounds the bar end;
- Filling the remaining gaps between the first connection component and the exterior surfaces of the bar end with copper and/or solder foil;
- Filling the narrow grooves introduced into the face of the bar with copper and/or solder foil;
- Inductive heating of the first connection element and the bar end and soldering while administering solder;

- At least visual inspection of the solder connection so created;
- Fitting a second connection element of copper to the free front of the first connection element by soldering;
- Testing the connection device created in this way for sealing tightness.

The invention is based on the consideration of using a minimum of modification on the existing connection device and to retain control on the quality of repair measures at all times. This involves among other things the deliberate creation of clean, defined, comparatively large area soldering points and the possibility of filling the gaps arising with filler strips of copper and solder or a combination of the two in such a way that only extremely small gaps remain that can subsequently be filled without residue during soldering as a consequence of capillary action. Furthermore, the two part character of the connection device is to be stressed, permitting the ability to access and therewith the ability to inspect the solder connections to be created. This two part character also enables great flexibility in configuring the two connection elements, especially with respect to their separation surfaces. These can be positioned in such a way that the first soldering/testing of the first connection element can be conducted simply and the second connection element enables almost "seamlessly" the connection to the existing coolant conduits as well as to the current connections.

Embodiments of the invention as well as further advantages attainable with it will be explained in greater detail below on the basis of the drawing.

Brief Description of the Drawings

Designs of the invention are schematically represented in the drawing, as follows:

Fig. 1 depicts a longitudinal section through a known connection device for the power connection and for supplying or removing liquid coolant to or from the hollow conductor elements of the stator winding rods of electric machines;

Fig. 2 illustrates a cross section through the connection device in accordance with Fig. 1 along line AA;

Fig. 3 shows a cross section through the bar end near the face after introducing grooves between adjacent conductor elements;

Fig. 4 reveals a longitudinal section through the bar end in accordance with Fig. 3;

Fig. 5 represents a longitudinal section through a two part connection device as it is used for the repair process of the invention, whereby grooves introduced into the face of the conductor bar are filled with special filler pieces;

Fig. 6 depicts detail X from Fig. 5 on an enlarged scale;

Fig. 7 shows a longitudinal section through a two part connection device as it is used for the repair process of the invention, whereby in distinction from Fig. 5 and 6, the hollow conductor ends are subsequently widened;

Fig. 8 reveals a longitudinal section through the bar end of Fig. 7 near the face after introducing bore holes at the meeting point of four hollow conductors and subsequent filling of these bore holes with copper round material;

Fig. 9 illustrates a cross section through the bar end in accordance with Fig. 8 along its line BB;

Fig. 10 depicts a longitudinal section through a connection device in which the separation surface between the two connection elements is shifted in the direction of the connection armature;

Fig. 11 provides a cross section through the bar end of a stator winding bar which also contains solid conductor elements in addition to hollow conductor elements.

Ways of Constructing the Invention

The point of departure for the repair process to be described below is a known connection device for power connection and for supplying or removing coolant liquid from the hollow conductors of the stator winding bars or an electric machine, as it is schematically in Fig. 1 and 2.

The stator-winding bar built up of hollow conductor elements 1 in the example is provided with a connection device in the form of a metal component 2. This surrounds the entirety of all conductor elements 1, projects beyond them outwardly while forming a water chamber 3 into which the cooling channels 4 open into conductor element 1, and ends in a connection armature 5 for supplying cooling liquid or removing liquid coolant. The conductor elements 1 are soldered hard among one another and with the metal component. The solder gaps represented excessively large in Fig. 1 and Fig. 2 filled with solder are designated with 6. The power connection S (indicated in dotted lines in Fig. 1) of the connection device is situated on the exterior of the water chamber 3 in the example and is omitted in Fig. 1 because it is not necessary for understanding the invention.

Leakages can now arise in the solder connection after long operating times of the machine. The wall of water chamber 3 can also itself become leaky if this is made of a copper

casting, as is typical in many older machines. The consequence is that cooling water gets into the winding headspace or (which is much more dangerous) gets into the conductor bar which must be avoided under all circumstances. Changing connection devices of this type is extremely troublesome owing to the constricted spatial conditions in the winding headspace. The removal of the stator winding generally does not come into question owing for economic reasons. Here the invention is used now.

The repair method of the invention is composed as follows and includes basically the following operations:

a) Removal of the existing connection device (2) from the bar end by inductive heating;

b) Cleaning the bar end in the region where the new connection device is to be fastened;

c) Material-removing processing of the front of the bar end, especially by milling;

d) Introducing narrow slots (7) between adjacent conductor elements (1) in the front of the bar in the transverse and vertical directions in order to remove "old" solder between the conductor elements to a specified depth;

e) Sliding on a first connection element (2a) of copper which completely surrounds the bar end;

f) Filling remaining gaps between the first connection element (2a) and the outer surfaces of the bar end with copper and/or solder foil;

g) Filling the narrow grooves (7) introduced into the face of the bar with copper and/or solder foil (10) or a combination of both;

h) Inductive heating of the first connection element (2e) and the bar end and soldering while administering solder;

i) At least visual inspection of the solder connection so created;

j) Fitting a second connection element (2a) of copper to the free front of the first connection element (2a) by soldering;

k) Testing the connection device (2a, 2b) created in this way for sealing tightness.

In step a), the metal component 2 is inductively heated to the melting temperature of the solder and withdrawn from the bar end. Devices for selected local heating of components and solder connections belong to the state of the art and for this reason will not be explained in greater detail.

After this follows cleaning of the soldering site as step b), which can take place by brushing or emery grinding. Moreover, the scaled material and porous old solder is removed to the bare copper or the bare solder.

Following that-step c) - the face surface of the conductor rod is processed by machining processing, preferably by milling, until a clean copper surface is reached.

In step d), narrow grooves 7 with a breadth of b = 0.05 mm and a depth t= 10-15 mm are introduced into the former solder gaps between adjoining conductor elements 1 as it is represented in Fig. 3 and 4. This can take place with a side milling cutter fastened to an auxiliary apparatus of the bar end. Here it is essential that breadth be of the grooves is so dimensioned that the exterior wall of the hollow conductor elements are engaged in the milling process so that

the side wall of groove 7 is processed up to the conductor copper up to the crossing point where four conductor elements meet.

In step e), the one half 2a of a metal connection element is slid onto the bar end prepared in this manner. This is manufactured of solid rolled copper and brought into the appropriate shape through machining processing, and thus is not a casting. The borchole in this first half largely corresponds at the bar end side to the original bar end in its dimensions. It protrudes a certain stretch s beyond the bar end. The protrusion dimension is to be selected as large as possible with a view toward subsequent application of the second connection element 2b which will be discussed later in connection with Fig. 10.

Now (step f), possibly still remaining gaps between the inner wall of the first connection element 2a and all outer surfaces of the conductor bar are filled with a first filler strip 9. These first filler strips 9 are known under the designation of SILFOS and is offered in a wide range of compositions and thickness between 0.1 mm and 1 mm. If needed, additional copper foil strips can also be used in order to fill even larger gaps as completely as possible.

In step g), the grooves 7 are now filled with second filler strips 10. Because here the groove width b (to be filled) is given by the milling tool and is defined by it, preferably filler strips 10 come into consideration that are made of a central copper layer 11 solder layers 12, 13 arranged on both sides, as can be gathered from the detail representation in Fig. 6. In this way, it is assured that the solder gaps can be kept as small as possible so that all gaps are filled on the basis of the capillary effect.

The bar end thus prepared with slid on first connection element 2a is now inductively heated and soldered while administering solder (step h). With careful execution, there is

inherently no danger of the solder penetrating into the cooling channels 4 and solidifying there since the rod ends run horizontally. This danger also does not exist because the inner wall of the cooling channels has become coated with an oxide layer in the preceding operation which prevents wetting by the solder.

After soldering the first connection element 2a, all soldering points are now inspected in step i) and examined for freedom from pores. Optimally, a test for sealing tightness can be conducted already at this stage, for example, by temporary sealing off the first connection element and pressure testing from the other side of the machine, for example, with helium gas.

After concluding the inspection, and if need after reprocessing the solder points, the second connection element 2b is now positioned on the first connection element 2a while interposing solder foils (not shown in Fig. 5) in step j) and soldered to this. This second element is made of copper like the first and brought into the appropriate shape by machining processing. It is thus not a cast element. Let it be pointed out for reasons of completeness that the power connection takes place with this and all further variants on the second connection element 2b, and the second connection element 2b was already prepared before soldering it to the first connection element. These are stepped to enlarge the front faces of both connection elements 2a, 2b to be soldered to each other and to simplify the mutual adjustment. The hard solder used for this connection can, moreover, have a lower melting temperature than that used for soldering the first connection element 2a with the bar end to prevent damage to those hard solder connections. In this connection, hard solders with a high silver component are used.

After finishing all solder connections, the final inspection in accordance with step k) is concluded where the testing for sealing tightness is conducted, with helium gas for example, in addition to an optical check.

Beside the repair method described above which is viewed as preferred by the applicant at this time, modifications are possible without deviating from the frame established by the invention. One of these modifications in particular concerns operation g). It is illustrated by way of example in Fig. 7 to 9.

After sliding on the first connection element 2a and filling any possibly remaining gaps between this and the outer surfaces of the bar end, "typical" solder foil strips about 0.1 mm thick are inserted into the grooves 7. Then the hollow conductor elements 1 are widened on their front face end until the grooves 7 milled in step 4 on the front face are closed. (Cf. Fig. 7 in which the grooves represented with exaggerated width are already filled with hard solder[.)] The remaining critical gaps 8 at the meeting of four adjacent conductors which cannot be closed by this widening are now bored out up to a depth of about 13 to 15 mm. It has moreover become apparent that it suffices to perform this with a drill from 1 to 1.5 mm. 13 to 15 mm long pins 14 of copper round material are now inserted into these bore holes (cf. Fig. 8 and), and in this way, the gap is closed. The purpose of this procedure is to close practically all gaps in order to create capillaries for the liquid solder into which it can flow and where it also remains. Steps h) to k) follow thereupon in the manner depicted.

As already explained at the beginning, with the repair method of the invention, two soldering procedures lying outside each other temporally and even spatially are to be completed. With such a method there always exists the danger that the quality of the preceding soldering

will be impaired with a later soldering process. In the present case, this danger can be avoided by corresponding selection of the melting point of the hard solder. Another possibility consists in that the connection device, more exactly the position of the separation surfaces of the two connection elements 2a and 2b is to be constructed in such a way that the second soldering point lies as far as possible from the first, thus increasing the distance s (cf. Fig. 5 to 7). This is nonetheless dependent upon the structural conditions at the repair site. In connection devices with a comparatively greater working area, as represented schematically in Fig. 10, the separation surface T of the two connection elements 2a and 2b is shifted far from the face of the conductor bar toward the connection armature 5. Nothing changes with respect to the repair methods described, however, at most with the exception that henceforth one and the same solder can be used for both hard soldering.

The repair method of the invention was described above on the basis of a conducting bar consisting of only hollow conductor elements 1. It is obvious that the method is also suited for stator winding rods that have solid conductor elements 15 in addition to hollow conductor elements (cf. Fig. 11). With an arrangement of this sort, following the theory of the invention, after removal of the original connection device, cleaning the outer surfaces of the bar end and milling its face flat, narrow grooves are introduced between all conductor elements 1, 15, thus also between adjacent hollow and solid or between two adjacent massive conductor elements 15. The alternative indicated for step g) (filling the grooves with solder foil and widening the hollow conductor elements 1) is indeed possible here, but depends upon the distribution of the hollow conductor elements in the conductor bar itself.

In any case, it is essential in all variant constructions of the invention to take care that all earlier soldering points are processed up to a certain predetermined depth from the bar end and in this way can be wetted for the "new" solder, and that all gaps which are too large for soldering are filled (capillary soldering).

Reference number list

1	Hollow conductor element
2	Metal component
2a	First connection element
2b	Second connection element
3	Water chamber
4	Cooling channels in 1
5	Connection armature
6	Soldering gaps
7	Grooves in face of 1
8	Crossing points of four conductor elements 1
9	First filler strip in 6
10	Second filler strip
11	Copper foil
12, 13	Solder middle layer (SILFOS)
14	Copper pin
15	Solid conductor element

Patent Claims

1. Method for repairing a connection device for electrical connection and for supplying and removing liquid coolant to or from the hollow conductor elements of the stator winding rods of electrical machines in which the connection device includes the hollow conductor elements, and if need be, also solid conductor elements are included and all conductor elements are surrounded by a metal component and are soldered to this or to one another, where the component protrudes beyond the conductor elements while forming a water chamber, and ending in a connection armature for supplying or removing coolant fluid, characterized by the following operations:

a) Removal of the existing connection device (2) from the bar end by inductive heating;

b) Cleaning the bar end in the region where the new connection device is to be fastened;

c) Material-removing processing of the front of the bar end, especially by milling;

d) Introducing narrow slots (7) between adjacent conductor elements (1) in the front of the bar in the transverse and vertical directions;

e) Sliding on a first connection element (2a) of copper which completely surrounds the bar end;

f) Filling remaining gaps between the first connection element (2a) and the outer surfaces of the bar end with copper and/or solder foil;

g) Filling the narrow grooves (7) introduced into the face of the bar with copper and/or solder foil (10) or a combination of both;

h) Inductive heating of the first connection element (2e) and the bar end and soldering while administering solder;

i) At least visual inspection of the solder connection so created;

j) Fitting a second connection element (2a) of copper to the free front of the first connection element (2a) by soldering;

k) Testing the connection device (2a, 2b) created in this way for sealing tightness.

2. Method according to Claim 1, characterized in that the grooves (7) introduced between the conductor elements (2; 1, 15) are filled with strips (10) which have a central copper layer (11) which are provided with solder foil (12, 13).

3. Process according to Claim 1, characterized only solder foil is placed in that in the grooves (7) mentioned, and then subsequently the hollow conductor elements (1) are widened until adjacent hollow conductor elements touch on the edges, and in that the remaining gaps are filled with copper pins (14) at the points (8) at which four hollow conductor elements (1) come together.

4. Process according to Claim 3, characterized in that the remaining gaps are bored out in advance at the points (8) at which four hollow conductor elements (1) come together.

5 page(s) of drawings in addition

DRAWINGS PAGE

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Figures 1-10

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